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Government Publications

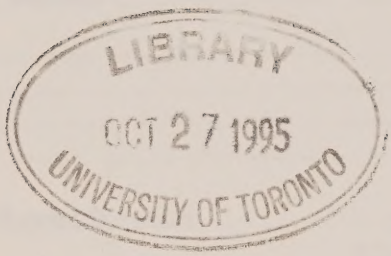
Building A Future

An Overview of Resource Development

Sand and Gravel

Canada

Sand and Gravel Exploration and Development On Reserve



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Bâtir l'avenir
Un aperçu de l'exploitation des ressources
L'exploitation des dépôts de sable et de
gravier dans les réserves

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Introduction

Sand and gravel are vital components of Canada's mining industry, with 250 million metric tonnes produced in 1990. These resources are used extensively on our roads in asphalt and as a road base, as well as by our building and housing industry as components of concrete.

Sand and gravel resources represent an opportunity for economic development for First Nations.

Of the 2,267 First Nations reserves in Canada, 854 have the potential for sand and gravel development, according to an inventory compiled in 1991 by the Department of Indian Affairs and Northern Development (DIAND).

The fact that hundreds of reserves are developing these natural resources underscores the economic opportunities they offer.

This booklet is for First Nations band councils and community members interested in considering sand and gravel developments. It will also be of interest to consultants working with First Nations and to developers, whether they are First Nations themselves, or private sand and gravel companies. An overview rather than a textbook on development, this booklet focuses on the components and activities associated with all aspects of sand and gravel developments.

This series of booklets, entitled *Building a Future – An Overview of Resource Development*, has been developed by DIAND in response to requests by First Nations for information on developing natural resources on reserves. Each booklet looks at a different resource from the point of view of a First Nations community.

Is development a choice? If so, what is the best way to plan and benefit from that development? *Sand and Gravel Exploration and Development On Reserve* provides information on exploration, development, permits, production, environmental concerns, benefits and costs of developing sand and gravel resources, and the development of policy relating to the industry.

The Importance of a Development Policy

The development of non-renewable resources, such as sand and gravel, or even the consideration of development, is easier with a development policy already in place. It gives your community the guidelines for investigating resource development; it provides for informed decisions on whether to proceed; and it helps maintain a focus on the priorities of the community for investment of time and money, and overall land-use planning strategies.

A development policy not only provides direction in dealing with the unexpected, it is its own road map, guiding those who will be implementing it on behalf of your community.

The need for a policy begins with your decision to pursue economic development. It helps to establish:

- the terms, conditions and limits of development;
- the extent to which economic development is a community priority;
- which development opportunities to study first;
- how to reconcile economic interests with environmental, social, cultural and traditional ones; and
- land-use plans.

When an opportunity to sell sand and gravel arises, be prepared to act. With a policy already in place to guide you, you are prepared for each stage of investigation, development and extraction of the resources.

A written policy, prepared in advance, is better than a verbal one. There is much less chance for misunderstanding later on.

The second point about a community development policy, probably the most important, is that it should be built through community participation. If your band members have been consulted on its formation, they are more likely to approve of and support it.

About Sand and Gravel and Your Community Development Policy

The term "sand and gravel" refers to a mixture of various sizes of rock fragments. The mixture ranges from clay and silt, to very fine to coarse sands, to pebbles and cobbles of stone. The term is used here to describe gravel, granular material, and aggregate and crushed rock. This booklet uses the terms interchangeably.

Sand and gravel fall into various categories.

- *Pit run gravel* is the natural, uncrushed granular material straight from the pit face, or ground, before processing. It is used in construction as general fill or road base material.
- *Crushed gravel* is the natural, granular material or rock that has been processed through screens and crushers to various sizes (20 millimetres in diameter is the most common). It is the standard material for road construction and for ready-mix concrete.

- *Asphalt aggregate* consists of various sizes of processed aggregate and is mixed with asphalt cement (tar). It forms the blacktop for highways.

- *Concrete aggregate*, a highly valued product, requires careful processing and mixing with cement to form concrete. It is used in house foundations and poured cement structures, such as bridges and office buildings.

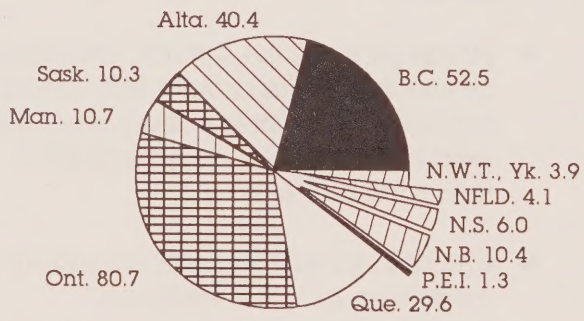
- *Sand products* are made up of specific size fractions which are washed and screened to produce sand of the right consistency for roads, bedding for pipes, general fill, mortar sand and sandblasting sand.

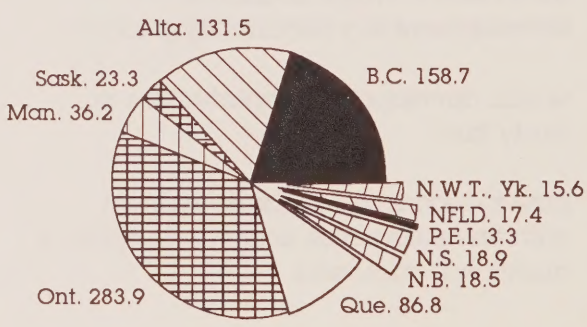
Next to wood and steel, sand and gravel are the most common construction materials. In Canada alone, in 1990, about 250 million metric tonnes of sand and gravel were produced at a value of $794 million. Table 1 shows the amount produced and its value for each province across Canada. Table 2 shows the major uses of sand and gravel.

Is the development of sand and gravel an option for your community? Consider the following questions.

- Are there sufficient quantities of sand and gravel deposits on your land for a commercial venture?

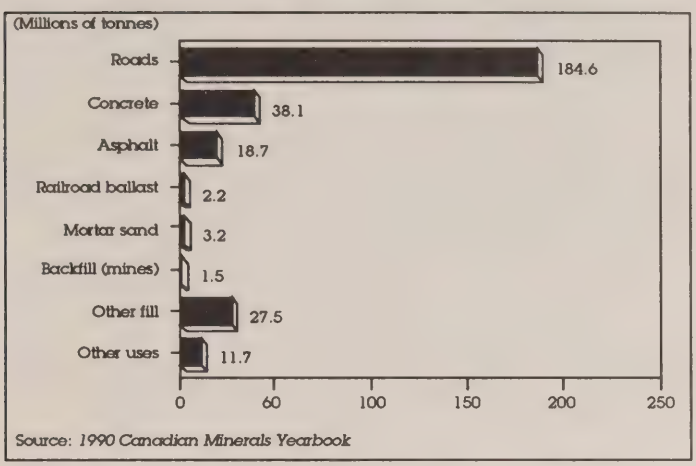
Table 1: Sand and Gravel, Production and Value by Province





Source: *1990 Canadian Minerals Yearbook*

Table 2: Sand and Gravel Consumption by Use



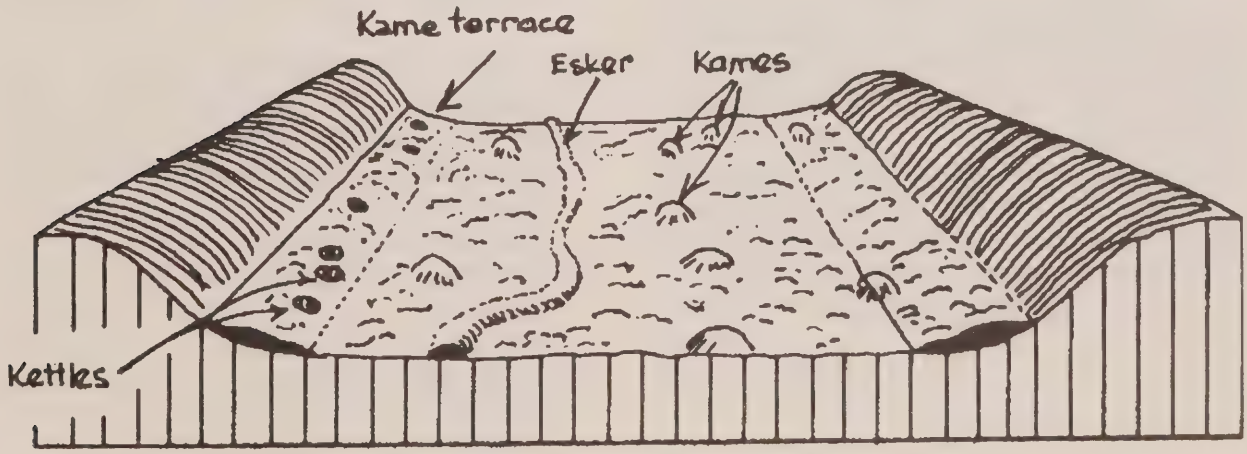
Source: *1990 Canadian Minerals Yearbook*

- Do the deposits have economic potential?
- What are the costs and benefits of developing them?

Answers to these questions will tell you whether to proceed; that is, they become an integral part of your development policy.

Does Your Reserve Have Sand and Gravel to Develop?

- The most obvious evidence of sand and gravel, is their presence on the ground surface. Other clues are landform features that suggest deposits. Flat-topped, bench-like steps or terraces along the sides and bottoms of large valleys are often sources of sand and gravel. In many areas though, vegetation, clay or silt overlie sand and gravel, making deposits difficult to identify.
- Previous on-reserve sand and gravel activities of any kind should indicate the presence of deposits.
- Local residents often have the most accurate information about the land, especially those who have drilled wells or excavated for roads and foundations.



Section of a glacial valley, showing landforms associated with sand and gravel, such as kame terraces and eskers.

- DIAND's mineral inventory, *Mineral Resource Potential of Indian Reserve Lands*, includes information on sand and gravel locations.

- A sand and gravel study may have been completed on your reserve. If a study was completed, copies are available from First Nations offices or DIAND's regional offices.

- Also worth looking at are surficial geological studies and aggregate maps prepared by provincial ministries of natural resources and by Natural Resources Canada. See the appendix for a list of addresses.

- Other indicators are private-sector interest, or past and present activity on or near your reserve.

- Inquiries from provincial highway departments or sand and gravel companies about access to First Nations lands can indicate interest for present or future projects.

Assessing Economic Potential

Once you have confirmed that sand and gravel deposits are on your reserve, the next move is to determine the quantity and quality. If the deposits are large and accessible, and the material from them is suitable for development, the next step is an investigation of the market, use and future demand.

Are the Sand and Gravel Deposits Large Enough for Development?

Sand and gravel deposits are measured by volume in cubic metres. The approximate amount of sand and gravel in the deposit is estimated by multiplying the length, width and thickness of the sand and gravel layer. The volume can vary in size from a few thousand cubic metres to millions of cubic metres. To be of commercial interest, the volume should be in the range of 100,000 to over 1,000,000 cubic metres. The following guide for development considerations assumes high-quality sand and gravel and a market nearby.

- **Under 10,000 cubic metres:** These small deposits would be useful for your own community for road maintenance and local use. A deposit of this size would be used up very quickly.

- **10,000 to 100,000 cubic metres:** A deposit of this size is enough for about 10 kilometres of basic road construction or several years of routine road improvements and maintenance. It is not large enough for commercial development, except perhaps as a one-time sale.

- **100,000 to 1,000,000 cubic metres:** This is a significant deposit and would provide enough sand and gravel for a major road construction project, a long-term source for road improvements and maintenance, or a small commercial operation with a life span of up to 10 years.

- **More than 1,000,000 cubic metres:** This is a large deposit with major commercial development possibilities. With an average annual extraction of 50,000 to 250,000 cubic metres, your community would benefit for many years.

Table 3: Estimate of Benefits from Sand and Gravel by Size of Deposit

Size of deposit (000 m^3)	First Nation use or commercial development	Possible life span (yrs)	Potential income to First Nation ($000)	Potential jobs
1-10	First Nation use	1-3	*	1 - 2
10-100	First Nation use or small commercial	1-5	$100	1 - 3
100-1,000	commercial	5-10	$1,000	3 - 5
over 1,000	large commercial	over 10	> $1,000	5 - 10

* Indicates benefits other than cash income. Funds normally committed to the purchase of sand and gravel may be used for other purposes.

Is the Make-Up of the Deposit Suitable for Development?

It is not just volume that dictates whether a sand and gravel deposit is good for development. Other physical characteristics have to be considered. For instance, not all rock particles make good gravel. Sandstone, shale and other soft rocks and minerals will lower the quality of sand and gravel deposits. Also, the types of rock in the sand and gravel can affect processing methods because some rocks are harder to crush than others.

There are various standards set for commercial sand and gravel. Industry standards established by the Canadian Standards Association (CSA) identify grain sizes and rock types for individual applications. Various provincial highway departments have aggregate specifications for highway construction and maintenance. And the Canadian cement industry has similar specifications for concrete aggregate.

Ideally, a commercially viable deposit has all the characteristics desired by a developer, such as a large volume of the different sizes of sand and gravel to meet industry and nearby markets specifications. For use in roads, concrete or other specific purposes, however, most sand and gravel needs improvement. For example, if the deposit used to surface a road contains too much silt or clay, it could cause dust problems or heave, crack and break apart when wet or frozen. There are many ways of improving the quality of the deposit; crushing and screening are normal operations. These processes increase the cost of the final product.

The geological characteristics of a gravel deposit are another factor affecting its commercial value. For example, a small, deep deposit is better suited for extraction than a thin layer spread over hundreds of hectares.

The Market: Who Will Buy and at What Price?

Your own uses for the sand and gravel on your reserve will have to be balanced against the benefits of sales to another party. If the deposit is large and of good quality, you can meet the needs of both.

The long-term demand for sand and gravel has been steadily increasing because of the growth of Canada's urban communities and industries, especially in highway construction and maintenance. Although provincial and municipal highway departments frequently have their own pits, they also buy directly from landowners and large sand and gravel producers. Because they are the largest buyers, they can usually influence local prices. However, some price negotiation is still possible.

Other buyers include construction contractors, concrete manufacturers and asphalt makers who use sand and gravel in ready-mix and other concrete products, and as backfill and bedding material for pipelines. A less common product, very pure silica sand, is used in glass and fibreglass insulation, sandblasting, computer chips and metallurgical flux.

Supply, demand, quality and distance to the market are factors that determine the price of sand and gravel. The best situation is to be located close to the market with little competition in the vicinity. Then you can obtain the highest prices.

Because sand and gravel are high-volume, low-value commodities, they are very costly to transport. In fact, it can cost twice as much to deliver sand and gravel as it does to extract and process. As a result, the value of these products decreases the farther they are from the market.

Pits that are closer to the market normally can undersell those farther away. Railway or water access may be cheaper than road for a major sand and gravel development and could make a remote deposit competitive.

To summarize: an accurate assessment of the financial prospects of sand and gravel on your reserve includes the distance from your buyers, transportation costs, competition, and the quality and quantity of the product.

What Does the Future Market Look Like?

Future prices for sand and gravel in your area could be affected by such factors as:

- major projects, such as highways or housing construction;
- oversupply (If this is the case, you might want to delay development until prices start to increase);
- increased local demand through urban sprawl; and
- dwindling local supply as existing deposits are used up.

Compare Costs and Benefits of Development

Benefits

- **Royalty income:** A project developer pays royalties based on the amount of sand and gravel removed. Negotiated by the First Nation, DIAND and the project developer, the royalty rate tends to follow local market prices and the amount the developer can afford to pay. Since provincial transportation departments and municipal governments are the largest bulk users of sand and gravel, they generally set the base market price. In 1990, royalty rates ranged from $0.25 to $2 per cubic metre. The average was around $1 per cubic metre.

- **Surface rents:** Also negotiated by the First Nation, DIAND and the project developer, these rents are paid by the developer for the land area used in the project. Local land values and the size of land required provide guidance on the rates, which range from $5 up to $300 per hectare per year. It is of mutual benefit to you and the developer to agree on fair rents. Overly high rents add to the developer's costs and reduce profitability. This in turn will affect the First Nation's benefits.

- **Bonus payment provisions:** Although somewhat less common, these are typically one-time, negotiated payments made by the project developer in one lump sum or on an agreed payment schedule. Bonus provisions can ensure income to the First Nation, even if the developer chooses not to develop the deposit.

- **Benefits to the First Nation's development corporation:** Through a corporation, your First Nation can exercise control over the management of the sand and gravel resource and participate in its development.

- **Employment and training opportunities:** Sand and gravel developments may provide job opportunities for your community members in business, management, geology, engineering and related fields. Heavy equipment operators, flagpersons and drivers would also be in demand.

- **Supply of sand and gravel for on-reserve projects:** Your community could use the sand and gravel for buildings, roads and other local projects.

Environmental Considerations

The environmental costs associated with sand and gravel development may be low compared with other types of mineral development. One reason is that land requirements are small, ranging from one to 40 hectares, depending on the size of the deposit. The adverse effects of a sand and gravel operation also can be corrected using good resource management. However, detrimental effects may include:

- noise;
- dust;
- smell, where an asphalt plant is involved;
- heavy traffic;
- damage to community roads from heavy trucks;

- trespassers and theft of gravel because of improved access roads;
- risk of injury and accident to children, wildlife and livestock caused by the pit operation;
- polluting of ground water and surface water during pit operations (the risk is higher if garbage is allowed to be dumped into the pit);
- risk of land damage because of poor erosion control during operations;
- destruction of trees, vegetation and habitat for wildlife;
- changes in land use (hunting, agriculture, etc.); and
- deterioration in the attractiveness of the pit's surroundings.

Many of these can be avoided or their effects reduced by good project planning, appropriate operational procedures and rehabilitation of the site. For example, a fence around the pit and a gate can reduce safety hazards. Pit rehabilitation programs can restore the area to near original beauty. Noise problems can be managed by scheduling work for particular periods of the day. (See the section entitled "Environmental Protection.")

Summarize Your Findings

- Is there sand and gravel on your reserve?
- Are the benefits of development likely to justify the costs?
- How does sand and gravel development compare with development in other sectors, according to those values which are important to your community?
- What size of development is possible – small or large scale?
- Should development start now or later?
- What design considerations, operating procedures and rehabilitation measures should be built into projects?

Even if you decide not to go ahead with a sand and gravel project, it is still a good idea to keep your community informed, identify any deposits on land-use maps and develop zoning policies. By ensuring that nothing is built over the sites and that the land is not allocated for other purposes, you keep your options open for later development.

Promotion

Before development of a sand and gravel deposit is possible, it needs two things: a market and a developer. If no market exists in your area for the sand and gravel on your reserve, plans will have to be put on hold because development cannot take place until a market is found. If there is a market, but no developer comes forward, it is up to you as a First Nations community to find or provide one or to postpone development.

You can use a variety of strategies to promote sand and gravel development on your reserve.

- Attract independent developers by:
  - basing your case for development on such factors as quantity and quality of the resource as well as specific market information (for example, a new road or other major development to be built in the area);
  - eliminating uncertainties through a clear definition of terms and conditions for third-party development; and
  - approaching developers already working in the area or who have expressed interest in expanding business in your area.

- Encourage your community members or the First Nation's development corporation to undertake the project.

- Look for joint-venture partners. Identify other firms in the sand and gravel business, major users of sand and gravel, and equipment suppliers. After determining their interest in a partnership, negotiate mutually beneficial terms.

- Check the long-term sand and gravel supplies in your region to decide on the right time to develop your deposits.

The Three Participants in On-reserve Sand and Gravel Developments

The three major players in on-reserve sand and gravel development are the project developer, the First Nation and DIAND.

The project developer, who is in business to sell sand and gravel and to make a profit, is responsible for:

- exploration for the sand and gravel;

- getting regulatory approvals and the right to extract and sell the resource;

- financing the project;

- complying with federal environmental legislation;

- developing and operating the pit or quarry;

- finding markets for the sand and gravel; and

- rehabilitating the site (subject to terms of the contract).

The First Nation, which wants the benefits development will bring, is responsible for:

- consulting with its community members;

- identifying an area for development, consistent with the community's land-use requirements;

- negotiating suitable terms and conditions with the developer;

- making sure DIAND incorporates its requirements into the permit or lease granted to the developer;

- participating in identifying any environmental issues; and

- helping to ensure the developer meets the terms and conditions of the development.

DIAND is responsible for:

- ensuring that the community has all the available information to make a decision on sand and gravel development;
- complying with the *Environmental Assessment Review Process Guidelines Order* by doing an environmental screening;
- authorizing the development of sand and gravel through permits or leases issued in accordance with the provisions of the *Indian Act*;
- ensuring with the First Nation that the developer meets the terms and conditions of the permit or lease; and
- crediting band accounts with royalties and other revenues from the development.

Negotiations

All parties want to negotiate the best deal possible, but this is not always a clear or easy task. Benefits that are less visible than direct economic ones, such as specific jobs and training for your First Nations members, are not always immediately apparent. Nor are the benefits of different combinations of rent and royalty income.

A lack of information is the biggest problem in negotiating favourable development terms and conditions. The more your negotiating team knows about local markets, the sand and gravel business, DIAND-related legal requirements, your own community needs and the skills of negotiation, the better equipped you are to get a good agreement. There are several things you can do to prepare yourself for negotiations.

- Gather as much information as possible. Contact DIAND's regional offices for advice and assistance, refer to mineral reports on your reserve, consult with provincial or territorial geologists, check nearby libraries and ask questions.
- Find out about the negotiating partner. What is its financial position? Does it have a good reputation in the industry? Why does the developer need your sand and gravel?
- Identify all the issues you want to negotiate. If you have a clear picture of your needs, more creative agreements can be negotiated which could include employment, education and skill enhancement.
- Before negotiations begin:
  - identify your negotiating team;
  - clarify its decision-making authority for the First Nation;
  - develop a negotiating position on all major issues; and
  - determine how much support you have in the community.
- During negotiations:
  - meet with the developer on friendly and professional terms in an atmosphere which implies that an agreement can be reached quickly; and
  - keep accurate records.

Understanding the Regulatory Process

First of all, it is against the law to remove sand and gravel from a reserve without the consent of the First Nation and written permission of the Minister of Indian Affairs and Northern Development or the Minister's representative. For a First Nation to initiate sand and gravel activity on its reserve, a permit or lease must be issued by DIAND. The terms and conditions of the permit or lease are drawn up in accordance with the First Nation's needs.

Permits and Leases

To initiate development, you have two disposition options: permit or lease, both of which require the consent of the First Nation. DIAND, as grantor, obtains the consent of the band council before granting a permit or lease.

A sand and gravel permit has the following characteristics.

- It does not grant exclusive possession, although fences and locks are permitted if safety is a concern.
- It is usually granted for a short period – section 58(4)(b) of the *Indian Act* refers to "temporary permits."
- The rights granted are not assignable; they cannot be transferred to another party.
- The permit can be cancelled at any time by the Minister, upon the First Nation's request, for just cause, such as if the terms and conditions are breached. The permit should also contain specific authority for cancellation.
- A permit makes no reference to an interest in the land.
- A permit should not be granted under the pretence of a lease.
- A permit does not allow for permanent structures to be built on the land.

When a developer wants conditions other than those described in a permit, then a lease is required. Such conditions may include:

- long-term development;
- exclusive occupation to remove large volumes of sand and gravel;
- erection of permanent structures;
- assignability of the rights to another party; and
- a granting of an interest in the land, such as the sand and gravel.

In order to dispose of large quantities of sand and gravel by way of lease, it is necessary to designate, in accordance with the provisions of the *Indian Act*, the surface area that will be the subject of the lease, together with any access requirements. Large quantities are amounts in excess of 100,000 cubic metres per year. A designation means that a First Nation designates a *particular* interest, on a temporary basis, so that the Minister may deal with that interest.

Not only does the developer need rights of access and rights to the surface sufficient to conduct operations, but there must also be a transfer of an interest in the sand and gravel so as to allow for its sale. In this

regard, the designation vote should also address the need for an absolute surrender of the interest in the sand and gravel which is to be extracted by the developer. In most cases, the sand and gravel surrender, and the designation, can be conducted in the same vote. Details of the designation process, and requirements relating to the surrender of the sand and gravel, can be obtained from DIAND regional offices, Lands and Trust Services.

Because most activity in sand and gravel development is for a short period of time and carried out under permit, the remainder of this booklet will deal with the development of sand and gravel deposits by permit.

The Permit Process

The Minister responsible for DIAND issues sand and gravel permits at the request of band councils. The permit holder may contract out certain parts of the operation or control all aspects directly. If the permit holder is a company owned by your First Nation, the legal authorities and responsibilities of the First Nation are separate and distinct from the permit holder.

The terms and conditions agreed to by the First Nation, the Minister and the permit holder are described in the permit. The First Nation determines when, where and who can develop sand and gravel on its reserve.

Before a permit is issued, a Band Council Resolution (BCR) is passed by the First Nation to authorize the Minister to issue a permit. The BCR clearly states what the Minister and the permit holder can do and protects the First Nation by documenting its terms and conditions.

The permit identifies the permit holder (the developer), the lands to be used, their size and location, and the terms under which the permit is to be issued. Recording all the terms and conditions helps reduce confusion and potential misunderstandings. A standard permit may have about 30 clauses dealing with:

- start and expiry dates of the permit;
- a description of the land involved, including an accurate legal description and a survey plan or sketch;
- the amount, type and reporting procedures for the sand and gravel involved in the disposition, including the maximum volume that can be removed;
- royalties to be paid to the Minister for each tonne or cubic metre removed;
- surface rents, if any, for the use of the land;
- bonuses (if any) and the conditions of payment;
- damage deposits or rehabilitation fees;
- environmental assessment requirements;
- provisions to protect the Minister and the First Nation in the event of accidents, disagreements, default and unforeseen difficulties;
- a schedule of payments to DIAND for deposit into the appropriate First Nation trust account, or to be divided between the band and an individual who is in lawful possession of the land. (The division would be described in the permit);

- the right of the Minister or First Nation to see the developer's financial records relating to the project;
- a description of how the project developer will report volumes, royalties and other fees paid by date or period;
- an outline of opportunities for First Nation members and businesses to participate in;
- any requirement relating to the rehabilitation of the land at the expiration of the term of the permit; and
- additional provisions which address specific concerns of the First Nation.

A permit usually is accompanied by:

- a legal survey plan;
- an operation and restoration plan outlining, in detail, the activities of the exploration, development, production and restoration process which becomes a binding part of the permit holder's commitment;
- the permit holder's proof of liability insurance;
- the permit holder's proof of damage deposit or performance bond; and
- an Affidavit of Execution, which is a document attesting to the signature of the developer when the permit is signed.

Once DIAND signs and issues a permit, the legal framework in which the project developer operates is established for the duration of the permit.

How a Permit Is Issued

There are a number of stages in issuing a permit.

- The project developer makes a proposal to the First Nation council, indicating the type and quantity of sand and gravel required, the timetable, the potential royalties and other pertinent details.
- The First Nation sends a copy of the proposal to the DIAND regional office. The regional office then forwards all information related to the development to the First Nation.
- Your First Nation council gathers information, assesses the proposal, consults with community members and decides whether to proceed. The developer, DIAND and other experts may be asked to make a presentation to the First Nation.
- Your First Nation council, DIAND and the project developer meet to discuss and negotiate the terms and conditions for the sale of the sand and gravel.
- Your First Nation council passes a BCR authorizing the Minister to issue a permit.
- DIAND officials draft a permit on the basis of the First Nation's negotiated terms and conditions and other standard clauses.
- Before any site preparation, processing or removal of sand and gravel begins, DIAND is required, under the *Environmental Assessment and Review Process Guidelines Order* (EARP) to complete an environmental screening.

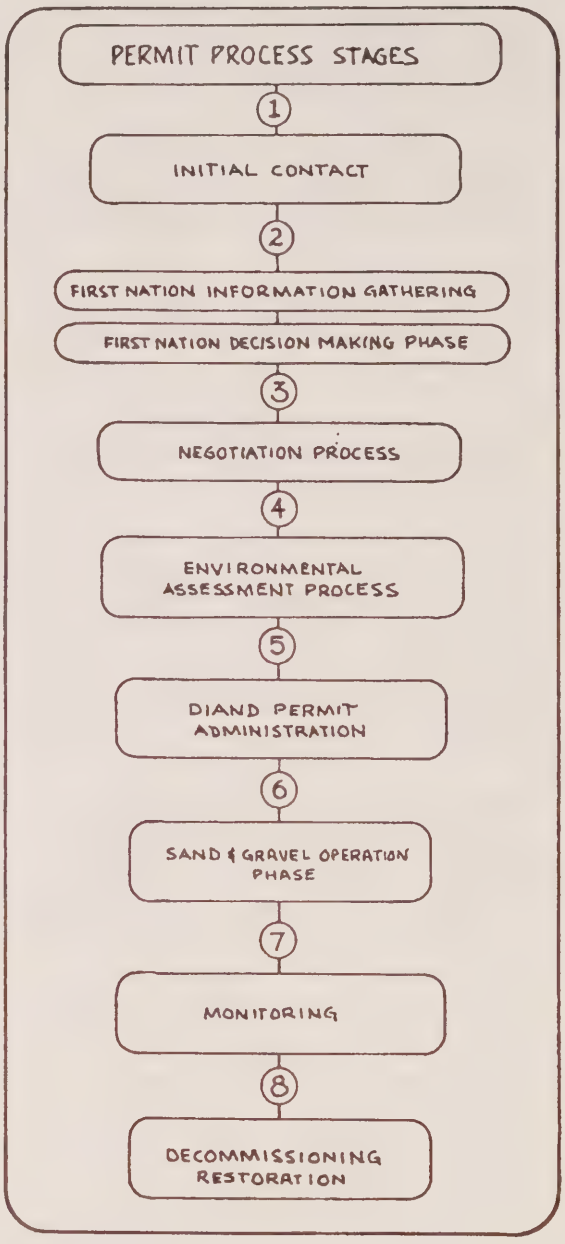
The screening is based on the permit holder's "operation and restoration plan" which will be used to provide details of the sand and gravel operation and rehabilitation. (See the later section "Environmental Protection.") The screening must be completed before the Minister of Indian Affairs and Northern Development or delegate signs the permit.

- On completion of the environmental assessment and review process, the Minister issues the permit. Four originals of the permit are circulated for signatures.

- The permit and attachments are returned to the issuing office for execution by the Minister. The Land Registry, the First Nation, the permit holder and the DIAND regional office each receive a signed original for their records.

- When the permit expires, or at required intervals, the permit holder provides a statutory declaration detailing the volume of aggregate removed from the site and the royalties paid. The statutory declaration is forwarded to the Minister.

- Representatives of the First Nation and DIAND inspect the pit area. If site conditions and the rehabilitation meet permit requirements, the permit holder is released from further commitment. If unsatisfactory, the damage deposit is withheld until the permit holder has met all the requirements. Any costs associated with this work are the responsibility of the permit holder.



This chart shows the major steps in the permit disposition process. Each step is essential to ensure that the actual operation meets the economic objectives of each party and to ensure that community resources are environmentally safeguarded.

Environmental Protection

The 1984 *Environmental Assessment and Review Process Guidelines Order* (EARP) requires that all federal departments involved in projects on Crown lands must review environmental implications before making decisions that affect the land.

In an environmental assessment of a sand and gravel pit, the developer looks at the effects of the project on:

- ground and surface water;
- noise levels;
- erosion and stability of slopes;
- land-use conflicts;
- unique physical features;
- permafrost;
- terrestrial and aquatic wildlife and habitats;
- attractiveness of the area;
- health and safety;
- local economy, employment, quality of life;
- social aspects;
- archaeological sites; and
- traffic from trucks and heavy equipment.

Before making a decision on the assessment, DIAND ensures that the environmental impact of the project on reserve lands is fully considered.

DIAND measures environmental impact based on:

- magnitude of the effect;
- frequency;
- likelihood;
- nature of impact (for example, direct or indirect);
- scope of impact (for example, local or regional);
- direction of impact (for example, positive or negative);
- duration (for example, short- or long-term);
- cumulative or residual effects; and
- available technology that could eliminate or minimize environmental effects.

The project developer's operation and restoration plan describes the potential impact of an operation on the reserve and surrounding lands. The operations part of the plan includes:

- proposed site and extraction methods; and
- stages of excavation and backfilling, stockpiling of topsoil, the height of the working faces and any provisions for access (security and public safety), drainage, storage, dust abatement, noise, haul routes, and erosion protection.

The restoration part includes plans for:

- slope reduction;

- reapplying topsoil;
- clean-up of the site;
- backfilling the pit; and
- erosion and drainage.

Your community will want to ensure that its environmental concerns are identified and addressed in the operational and restoration plan. DIAND and Environment Canada, provincial departments of transportation and natural resources and many private-sector consultants can provide environmental expertise and assistance.

Project developers should consult local residents early in the process because, without community support, an environmental concern could jeopardize the success of a project if left unresolved.

Understanding the Sand and Gravel Business

When you embark on a sand and gravel project, it is to your advantage to know the business, even if a commercial developer is actually carrying out the work. There are seven stages of activity:

- exploration;
- regulatory approvals;
- financing;
- site preparation;
- extraction;
- processing; and
- site rehabilitation.

It is usually the project developer who assumes responsibility for these tasks and who undertakes to start and run the business. Without a developer, there is no project. The developer may be:

- a third party, completely independent of your community;
- a development corporation controlled by your First Nation or its members; or
- a joint venture controlled by the First Nation and an independent third party.

Whatever the situation, the project developer is considered a separate entity from the First Nation, one of the three participants in the project.

Exploration

A broad range of field search and measurement activities are used to gather information about the location, size, quality, type and nature of a sand and gravel deposit. The purpose of this exploration is to establish whether the deposit is suitable for development.

How much you spend on exploration will depend on market conditions, project size, value and intended use of the resource. A step-by-step approach is a way to minimize the costs of what can be an expensive undertaking. For example, conducting a detailed testing program over a large reserve without studying the reserve landscape first to determine which areas have the most potential for sand and gravel deposits would be costly.

Geological exploration is usually conducted in five stages. These are not hard and fast rules, but logical steps through the process. For sand and gravel development, stages I, III, V in particular are often followed.

Stage I: Literature Research Studies and Local Sources

This is a preliminary geological assessment of a reserve and its surrounding area for sand and gravel potential. It is based on a review of available published geological information. The *Mineral Resource Potential of Indian Reserve Lands*, compiled by DIAND, assesses and rates the mineral development potential of reserves.

Provincial ministries of natural resources, the Geological Survey of Canada and DIAND may have additional or updated information. Maps or reports on the surficial geology, aggregate resources and past and present gravel pits in the area may show known sand and gravel resources.

Talk to residents and local operators of sand and gravel companies to help identify resources in your area. All this information will focus your search on the most likely locations to check first.

Stage II: Field Surveys

At this stage, a geologist visits the identified sites, reviews local land features, notes which features may have potential and collects information about the areas that look promising.

A geologist visits surface exposures of sand and gravel to determine type, quality and area covered.

Possible sites can either be paced off or measured with a distance-measuring device, such as a hip-chain, to estimate the size of deposit. Surface evidence of deposits is often found at road cuts or holes dug for foundations. Abandoned or existing pits can also provide clues.

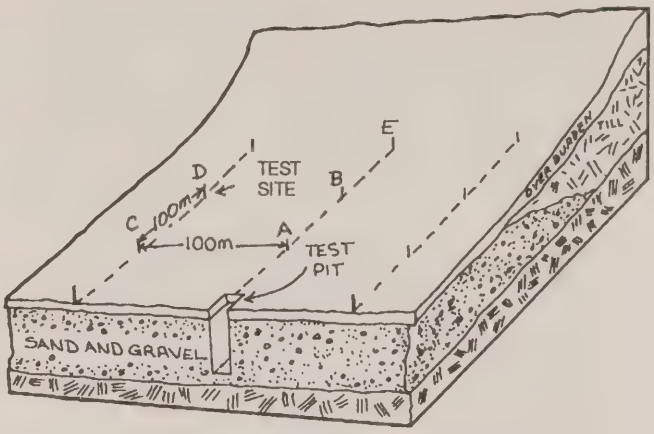
The geologist collects and labels samples of sand and gravel material found at each site for later identification and analysis. The geologist would also plan for the next phase, including equipment needed, access to potential areas, scheduling of work and meeting with the band council to keep them informed of work completed and results, and the direction of future work.

Stage III: Geoscientific Studies

If the field surveys are positive, the next step is a closer examination of the most promising sites. Techniques include geological mapping, test pitting and sampling, and more detailed geophysical surveys to determine the location, volume, extent and quality of sand and gravel deposits on your reserve. The purpose is to focus on smaller areas to collect information on the deposit. As the need for more information increases, so does the cost of the study.

To carry out a detailed testing program, the developer's first step is to identify the equipment needed. A backhoe is adequate for digging test pits four or five metres deep.

A backhoe can easily dig a test pit to provide visual information on the material in the potential deposit



Typical layout of a grid over a sand and gravel deposit.

For thicker deposits, a truck-mounted auger drill with the capacity to drill 20 or 30 metres is used. Choice of equipment is also influenced by other factors such as accessibility to the area and the presence of trees or crops. After finding and pricing equipment, the developer arranges for rentals and operators, schedules the work and decides on the sites to be tested. At this point, the developer also will have chosen a laboratory to analyse the samples.

Of the many exploration techniques used, test pitting, geophysical surveys and geological mapping are the most common for sand and gravel exploration.

Test Pitting: In this survey method, a grid pattern is laid out over the potential sand and gravel deposit. Straight lines equally spaced, separated by measured distances and intersecting at 90-degree angles, are brushed or staked over the potential deposit.

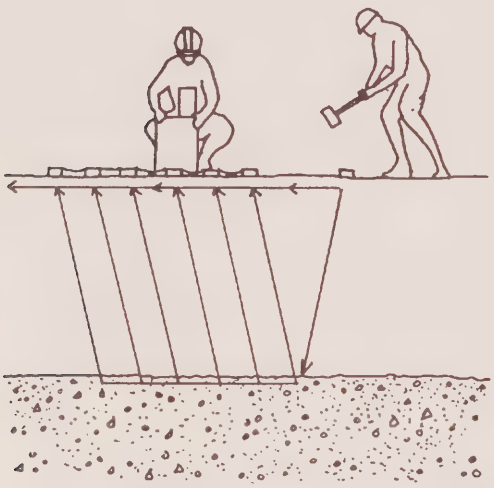
In the example, two test pits, A and B, are dug 100 metres apart. Since both contain sand and gravel, it is assumed that the material is consistent between the two pits. Two other test pits, C and D, are dug. The new pits are 100 metres to the left of A and B and 100 metres apart. If all the test pits show sand and gravel, it is assumed that the entire area, 100 metres by 100 metres, contains sand and gravel.

Test pit E is excavated but no sand and gravel are found. This means the gravel deposit ends somewhere between B and E. It can be assumed the gravel material stops halfway, or in this case, 50 metres from B. This process is repeated in the test area until the outline of the gravel deposit is determined. If the deposit is suspected to be very large, the distance between the test pits can be increased up to 500 metres.

Once the outline of the deposit is completed, the volume of the deposit is calculated using the thickness of the sand and gravel found in the test pits.

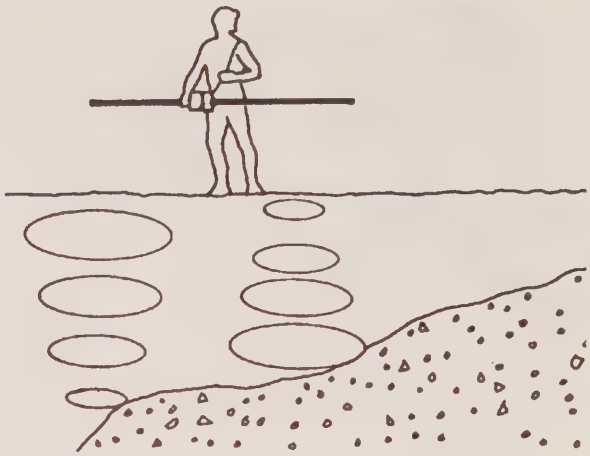
At each test pit where significant sand and gravel are found, a 15-kilogram sample is collected, labelled and sent to the laboratory. The lab tests identify the quality, characteristics and suitability of the material for various uses.

Geophysical Surveys: Often used in combination with test pitting, geophysical surveys use electronic instruments to measure the characteristics of the underlying sand and gravel without digging holes.



Using the seismic method, underlying sand and gravel deposits are discovered by using sound levels.

The principal methods are seismic and electromagnetic (EM). Seismic systems use sound waves to measure the thickness and depth of different components of the material beneath the surface.



With the electromagnetic method, the electromagnetic properties of rocks are used to determine the location of underlying sand and gravel.

EM uses invisible electromagnetic properties of the rocks to determine the kind of material. Using grids in much the same way as in test pitting, the geologist can cover larger areas with these methods.

Geological Mapping: A map is drawn of the location of the sand and gravel deposit with the grid showing the location of the pits, the outline of the deposit and the results of the geophysical surveys.

Measurements of a deposit's thickness, descriptions of the material and the results of later sample analysis will give the total volume and quality.

Once the analysis is complete, the geologist prepares a summary report on each site. The results of these surveys will be the basis for your decision to proceed with further assessment, or to prepare a plan for extraction.

Stage IV: Test Drilling

In rare situations, test drilling is needed to determine the depth or area of a deposit. In such cases, a few holes are drilled using specialized and more expensive equipment, such as a Becker hammer drill, one of the few drills capable of penetrating gravel. In most cases, however, the completion of a detailed site investigation provides enough information to begin developing the deposit.

If you are considering a quarry operation, detailed test drilling is necessary to determine the quality, quantity, blast patterns and crushing characteristics of the bedrock. A quarry would usually be developed in limestone, dolomite or granite.

Stage V: Market/Feasibility Studies

The final stage of exploration looks at the local market conditions, current and future demand, prices and all the engineering and equipment necessary for the start-up of a new operation. Although a formal market or feasibility study could cost as much as $50,000, it provides crucial information to help the developer decide whether to make a major financial commitment to proceed.

For small operations, the feasibility study would look at specific needs and buyers and would probably be limited to the specific application. Very small projects may be able to rely on informal surveys and a knowledge of local conditions.

Regulatory Approvals

The project developers are responsible for securing all necessary regulatory approvals. They cannot work on reserve land without the consent of the First Nation, a permit from the Minister of Indian Affairs and Northern Development and a completed environmental assessment. The cost of securing regulatory approval is a factor in project budgets. These costs vary depending on the size of a project, but normally they range from one to five percent of the total project cost. (See the section "Understanding the Regulatory Process.")

Financing

Since project developers usually incur costs for exploration, regulatory approval, equipment and site preparation well before revenues from sales begin to come in, project financing comes early in the development process. The following table outlines the estimated costs associated with the development of various sizes of projects.

Table 4: Development Costs of Sand and Gravel Projects

PHASE	10,000 (m^3)	100,000 (m^3)	1,000,000 (m^3)
Exploration			
Research (Stage I)	$5,000	$5,000	$5,000
Field Surveys (Stage II)	$1,000	$3,000	$5,000
Geoscientific Studies (Stage III)	$10,000	$30,000	$50,000
Test Drilling (Stage IV)	na	na	$50,000
Feasibility Studies (Stage V)	na	$5,000	$50,000
Development	$2,000	$5,000	$20,000
Rehabilitation	$1,000	$5,000	$30,000+
Total	$19,000	$53,000	- $210,000+

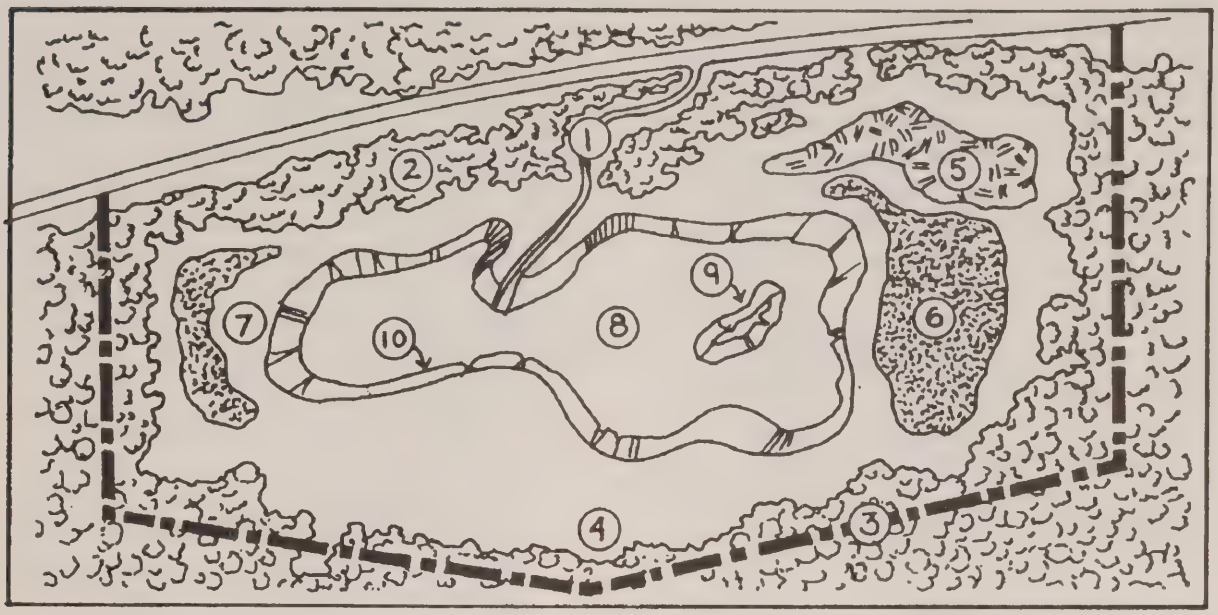
There are a variety of financing arrangements open to developers including renting or leasing equipment to reduce initial capital costs.

Site Preparation

Developing a pit site takes time and money. From the very beginning, the pit should be well designed for safe and efficient operation.

When designing a pit, consider the following:

- Trees cleared from the site can be used for local building or sold as firewood; stumps and brush may be burned or mulched.
- Topsoil is a valuable commodity to be saved for the land restoration process. Standard procedure is to scrape off and stockpile soil close to the site.
- Overburden is unwanted material on top of sand and gravel, such as glacial sands, clays and peat, which must be pushed or scraped off and stockpiled before excavation can begin. This material is also used in the restoration process. If the overburden is more than two metres thick, it may be too costly to remove.
- The location of stockpiles is very important. The developer does not want to have to move an overburden or topsoil stockpile at great expense because it is located over another part of the deposit where future extraction is supposed to begin.



① DOGLEG ACCESS
② BUFFER STRIP
③ FLAGGED/FENCED BOUNDRY LINE
④ EDGE OF CLEARING
⑤ TOPSOIL PILE
⑥ OVERBURDEN PILE
⑦ WORKING SPACE
⑧ PIT FLOOR
⑨ MATERIAL STOCK PILE
⑩ WORKING PIT FACE

Example of a pit site designed with safety and efficiency in mind.

- The developer may have to build a system of culvert pipes, ditches and collection pools to drain surface runoff and prevent erosion.
- Fences and gates around the pit will discourage trespassers, livestock, garbage dumping and theft. Their presence could also be a factor in helping to protect the developer in any legal actions that might arise out of an accident.
- For privacy and safety, the pit and access roads should not be visible from public roads.

Extraction

Backhoes, front-end loaders and bulldozers can usually dig out the sand and gravel material directly from the working face of the pit.

Because of the instability of sand and gravel, the pit face should never be allowed to get higher than five to eight metres for safe extraction. For deposits of 20 to 30 metres, benches or steps are often used; this approach, called "benching," is not only safer, it also permits easier and less expensive restoration of the land after the pit is closed. Pit floors are best kept flat and reasonably

clear of holes to maintain drainage and minimize waste. The pit floor should be graded, or sloped slightly away from the pit face, to allow water to drain away. Generally, extraction is stopped once the water table is reached because going deeper can cause major drainage problems. A pit can become a lake very quickly.

Water passes freely through sand and gravel. Whatever spills onto the pit floor – fuel and oil from heavy equipment for example – leaks very quickly into the ground water, contaminating water and wells in the surrounding area.

The discharge of muddy or silty water from an extraction site is strictly regulated by federal and provincial authorities because of the potential danger to fish habitats and spawning grounds in nearby creeks and rivers.

Processing

Natural sand and gravel can be used for many purposes, but to meet the specific needs of some customers, processing is necessary. Processing is a highly developed procedure requiring special skills and expensive equipment to screen, crush, sort, wash and stockpile the material. A gravel operation can make between five and 10 different products.

Processing usually follows these steps.

- A truck or front-end loader dumps raw gravel from the pit into a hopper where the largest rocks (usually greater than 25 centimetres in diameter) are screened out.

Processing steps and equipment necessary to produce crushed gravel products.

- Conveyor belts carry a continuous stream of material through crushers which break up the stones and screens the material by grain size. The bigger chunks are stockpiled for reprocessing.

- If a deposit contains too much silt, a wash plant using water jets will remove it, or reduce it.

- A series of conveyor belts carries processed sand and gravel products to a storage pile or loads it directly onto trucks.

The initial capital cost of a sand and gravel business is high, but the purchase of a processing plant can be spread over many years. To make this kind of investment worthwhile, at least one large deposit of sand and gravel and a good, long-term market are necessary.

As an alternative, a developer might contract out the crushing and screening tasks. This would allow a new business to focus on the local market and the quality control of a product, a requirement necessary to meet the high standards set by many customers.

Site Rehabilitation

Planning for the rehabilitation of a pit during the early development stage will make the restoration process easier. Ugly, abandoned pits affect the area's appearance, productivity and safety for generations. Restoration, which is the developer's responsibility, is now a routine cost of doing business. A reputable company will carry out ongoing restoration, instead of waiting until operations finish.

- Slope reduction is usually the first step in pit rehabilitation. Gravel pits often end up with very unstable and steep, almost vertical work faces. To lessen the risk of landslides and injuries, and to minimize erosion from surface runoff, these faces are reduced to gentler grades.

Slope rehabilitation - Cut-Fill Method. This method is used to reduce the slope of the work face for safety reasons and to minimize erosion as well as restoration costs.

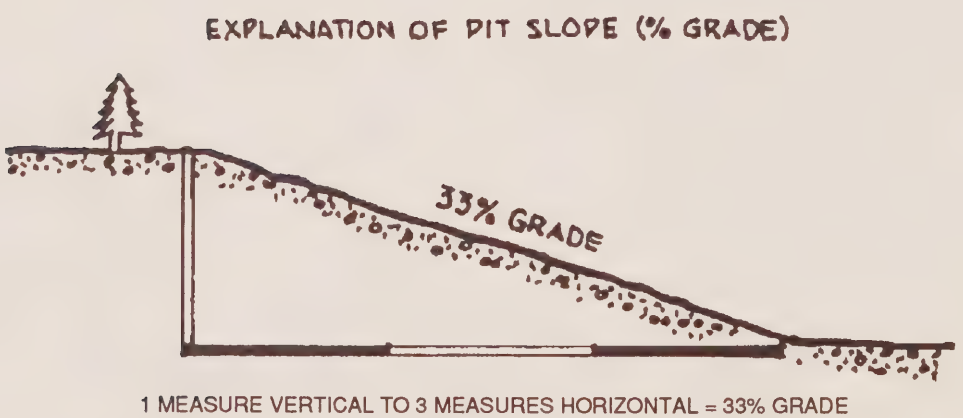
Flatter inclines also permit the seeding and growth of plants and are more suitable to other forms of land use. The maximum acceptable slope in the restoration of a pit is a ratio of one vertical to three horizontal (33 percent grade). This means that for every metre of height there should be three metres of distance from the bottom of the working face.

- All garbage, supplies and equipment are taken from the site. Pits should not be used for the disposal of domestic, industrial or toxic waste because of the porous quality of sand and gravel and the potential for contaminating ground water.

- The stockpiled topsoil and overburden are spread over the site to encourage revegetation.

- Whether the developer is responsible for seeding or further landscaping of the site depends on the original agreement.. However, in many parts of Canada, reseeding will occur naturally.

- Before development even begins, the First Nation could plan the end use of the land. For instance, your community may want to landscape or seed the rehabilitated land or use the site for housing, a sports park or commercial development.



Explanation of the one-to-three slope.

Conclusion

This booklet tracks the issues of sand and gravel development by flagging each stage where decisions can be made to proceed or abandon the process. Decision-making tools include a development policy and a full understanding of exploration and development (including costs, an understanding of the environmental risk, and an implementation strategy if you decide to proceed).

A First Nation must measure the benefits against the possible costs. The decisions are yours. They are easier to make if you can base them on information about every stage of the process.

Glossary

abrasion resistance: tests, such as the Los Angeles Abrasion Test, used to measure the aggregate's resistance to crushing and pulverizing under conditions similar to those encountered in processing and use.

absorption capacity: a measure of the porosity of the rock types of which an aggregate is composed. Porous rocks tend to break down when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

aggregate: sand, gravel or crushed stone. Originally it meant any material used to make concrete. More informally, aggregate means any granular material used for any number of construction and other industrial purposes.

air photo: a picture of the earth taken from an airplane.

asphalt: a mixture of oil and aggregates used in paving.

backhoe: an excavating machine fitted with a hinged arm and bucket.

belt conveyor: a moving belt used to transport large volumes of loose material along a designated route from a large source (for example, crusher or stockpile).

bench: a step of level earth or rock that is cut into a slope to break a steady incline.

buffer strip: a strip of uncleared land, which is undisturbed, to hide the pit from view.

bulldozer: a wheeled or crawler tractor equipped with a reinforced, curved steel plate mounted in front for pushing excavated material.

cement: a dry powder that hardens after mixing with water. It is an ingredient in concrete.

clast: an individual constituent, grain or fragment of a sediment or rock, produced by the weathering of a larger rock mass. Synonyms include particle and fragment.

concrete: a mixture of sand, gravel, cement and water which hardens when dry.

crushed rock: angular fragments of rock produced by passing gravel through a mechanical crusher.

crusher: a machine used to break rock or gravel into smaller fragments.

CSA: Canadian Standards Association. An organization that sets standards for the testing and composition of engineering materials in Canada.

deleterious lithology: a general term for rock types that are chemically or physically unsuited for use as construction or road-building aggregates. Rock such as chert, shale, siltstone, and sandstone may deteriorate rapidly when exposed to traffic and environmental conditions.

dogleg: a "jog" or sharp curve in a right-of-way which conceals a clearing from view.

erosion: the wearing away of soil or rock fragments by running water, wind, ice or gravity.

esker: a long, winding ridge of sand and gravel deposited by meltwater rivers flowing through the ice of a glacier.

extraction: the taking of material from its undisturbed location.

geomorphology: the study of topographic features which are responsible for creating landforms and landscapes.

gradation: the proportion of granular materials, which constitute a natural sand and gravel according to particle size. The size limits for different particles are as follows:

boulder	>256	mm
gravel (cobble)	64-256	mm
gravel (pebble)	4-64	mm
gravel (granule)	2-4	mm
sand (coarse)	0.5-2	mm
sand (medium)	0.25-0.5	mm
sand (fine)	0.074-0.25	mm
silt, clay	<0.074	mm

granular base course: components of the subgrade below the pavement of a road designed to provide strength, stability and drainage, as well as support for surfacing materials.

granular material: materials which are commonly known as sand and gravel. Technically, granular materials include silt, sand, gravel and cobbles.

grizzly: a coarse screen or series of parallel rods or bars used for rough sizing of gravel.

kame: mounds of poorly sorted sand and gravel deposited by glacial meltwater in depressions on the glacier surface or at its margin.

lithology: the description of rocks on the basis of such characteristics as colour, structure, mineralogic composition and grain size. Generally, the description of the physical character of a rock.

loader: a machine, such as a mechanical shovel, used for loading bulk materials.

meltwater channel: a channel eroded by glacial meltwater either under the glacier or along its side.

moraine: a landform made up of accumulated glacial debris.

outwash: sand and gravel transported away from a glacier by meltwater streams.

overburden: any material that covers a deposit of useful material or minerals.

pit or quarry operation: activities at a pit or quarry associated with the opening up of the site or any portion thereof; the extraction, processing, stockpiling or removal of materials from the site; or the restoration of the site. It includes any works, machinery, buildings and premises belonging to or used in connection with the pit or quarry.

pit: a site where granular material, not including consolidated rock, is being or has been taken.

pollution: the destruction or impairment of the purity of the environment.

processing: the screening, blasting, crushing, draining or any other preparation of excavated material before stockpiling or removal.

quarry: an open, surface excavation for the extraction of stone.

recontouring: grading disturbed land to an acceptable landform.

rehabilitation: the treatment needed to return an abandoned pit site to a productive state. This might involve returning the site to its natural state by planting vegetation or landscaping. Or, rehabilitation could involve development as housing or recreational land.

resistivity meter: a portable instrument that measures the conductivity of a magnetic field through various surface materials. It is used to determine the presence of material such as sand and gravel.

restoration: the rehabilitation of a pit or quarry to return it to a stable condition and to make it look as natural as possible.

river terrace: an accumulation of river deposits along the sides of a river valley which were deposited when river levels were higher.

sand and gravel: a mixture of various sizes of rock fragments.

screen: a large grid or mesh used to sort aggregate so that it may be stored in piles of similar grain size.

silica sand: sand with a high percentage of silicon dioxide.

slope: an inclined surface with a ratio of two horizontal to one vertical (2:1) or three horizontal to one vertical (3:1).

soundness: the ability of the components of an aggregate to withstand the effects of various weathering processes and agents.

stereoscope: a viewing instrument that uses special lenses and/or mirrors to produce the illusion of depth when looking at pairs of overlapped air photos. A stereoscope makes air photos look three dimensional, allowing for easier identification of elevation changes and landforms.

terrace: sloping ground cut into a succession of benches to control surface run-off, minimize soil erosion and assist revegetation.

till: unsorted and unstratified rock debris deposited directly by glaciers. It ranges in size from clay to large boulders.

Appendix A

Names and Addresses of Government Agencies

The reader is advised to verify the telephone numbers of the provincial government geological agencies as the numbers may change.

British Columbia
Ministry of Energy, Mines and Petroleum Resources
Geological Survey Branch
Chief Geologist's Office
553 Superior Street
Victoria, B.C.
V8V 1X4
(604) 387-0687

Alberta
Alberta Department of Energy
Mineral Resource Division
9915 108 Street
Edmonton, Alta.
T5K 2C9
(403) 427-7749

Saskatchewan
Saskatchewan Energy and Mines
Geology and Mines
1914 Hamilton Street
12th Floor
Regina, Sask.
S4P 4V4
(306) 787-2560

Manitoba
Manitoba Energy and Mines
Geological Section
Eaton Place
535-330 Graham Avenue
Winnipeg, Man.
R3C 4E3
(204) 945-6567

Ontario
Ontario Geological Survey
Geoscience Branch
Willet Green Miller Centre
933 Ramsey Lake Road
Sudbury, Ont.
P3E 6B5
(705) 670-5866

Quebec
Ministère d'énergie et des Ressources
5700 4th Avenue West
Charlesbourg, Que.
G1H 6R1
(418) 646-2727

New Brunswick
New Brunswick Department of Natural Resources and Energy
Mineral and Energy Division
P.O. Box 6000
Fredericton, N.B.
E3B 5H1
(506) 453-2206

Nova Scotia
Nova Scotia Department of Natural Resources
1701 Hollis Street
Founder's Square, 2nd Floor
P.O. Box 698
Halifax, N.S.
B3J 2T9
(902) 424-4162

Prince Edward Island
Prince Edward Island Department of
Economic Development and Tourism
Energy Branch
11 Kent Street
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7N8
(902) 368-5010

Newfoundland
Newfoundland and Labrador Department
of Mines and Energy
Geological Survey Branch
95 Bonaventure Avenue
P.O. Box 8700
St John's, Nfld.
A1B 4J6
(709) 729-3159

Appendix B

Geological Survey of Canada Offices

Publications Distribution
Geological Survey of Canada
601 Booth Street
Ottawa, Ont.
K1A 0E8
(613) 995-4342

Geophysical Data Centre
1 Observatory Crescent
Ottawa, Ont.
K1A 0Y3
(613) 995-5326
Fax: (613) 992-2787

Cordilleran Division
100 West Pender Street
Vancouver, B.C.
V6B 1R8
(604) 666-0271

Pacific Geoscience Centre
9860 West Saanich Road
P.O. Box 6000
Sidney, B.C.
V8L 4B2
(604) 363-6500

Quebec Geoscience Centre
2700 Einstein Street
P.O. Box 7500
Sainte-Foy, Que.
G1V 4C7
(418) 654-2604

Institute of Sedimentary and Petroleum Geology
3303 33rd Street North West
Calgary, Alta.
T2L 2A7
(403) 292-7000
Fax: (403) 292-5377

Atlantic Geoscience Centre
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, N.S.
B2Y 4A2
(902) 426-3410